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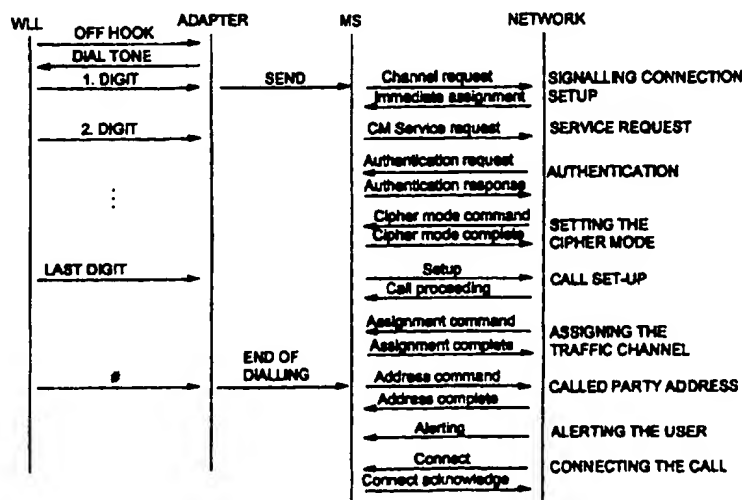
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(54) Title: A RADIO UNIT AND A METHOD FOR CONNECTING A FIXED SUBSCRIBER STATION TO A WLL SYSTEM



(57) Abstract

The invention relates to connecting a subscriber station (1) of a fixed network, such as a telephone set, to a WLL system. The radio unit (10, MS) to which a WLL subscriber station (1) is connected initiates connection and call set-up in the radio network immediately when the first digit is received from the subscriber station. Thus, the directory number of the called party is dialled simultaneously with setting up a signalling connection between the radio unit and the MSC in the radio network. The radio unit buffers the digits of the dialled directory number until the end of dialling. When the dialling has ended, the radio unit sends the directory number of the called party to the radio network (address command). As a result, the delay typically associated with the call set-up of a cellular radio network is minimized in WLL applications.

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A radio unit and a method for connecting a fixed subscriber station to a WLL system

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Field of The Invention

The invention relates to connecting a subscriber station of a fixed network, such as a telephone set, to a radio network.

10

Background of The Invention

The most expensive and difficult part in setting up conventional fixed telecommunications networks is cabling, which interconnects each subscriber with a local exchange. In many cases, it is therefore advantageous to replace fixed subscriber cables with a radio connection, which may easily and quickly be established for providing an access for the subscribers to a public switched telephone network (PSTN). In such a case, the subscriber network comprises, like a standard radio telephone network, base stations connected to an exchange and communicating to a fixed radio unit via the radio path. The radio unit, in turn, provides a conventional subscriber line, to which it is possible to connect any subscriber station of a fixed telecommunication system, such as a telephone set. Thus, the radio path is transparent to the user and provides a point-to-point connection between the telephone set and the exchange. Such a system is often termed as a Wireless Local Loop. Since a WLL radio system is usually an extension of the standard PSTN network, standard numbering of a telephone network is typically employed therein. Accordingly, call set-up carried out from the subscriber end should be as similar to call set-up in a fixed network as possible in order that the radio

connection would be as "transparent" as possible.

For reducing planning work and costs, it is advantageous to implement the WLL networks by utilizing existing radio network architectures, such as the pan-European mobile network GSM (Global System for Mobile Communication), or the Nordic Mobile Telephone network NMT. A WLL network may be embodied even as a part of a standard mobile network, whereby there may be both WLL subscribers and mobile subscribers in the same network. Call set-up carried out by a mobile subscriber does not, however, correspond to the call set-up carried out in a fixed network as such. It is possible to determine in the mobile services switching centers case by case how to route different calls. Typically, it is defined in the mobile services switching centers that the local number (numbers beginning with digits 2 to 8 in Finland) refers to the internal telephone number of the mobile network. If a mobile subscriber wishes a call to be routed out of the mobile network to the PSTN, he must dial a national area code (a number starting with 9 in Finland) before the PSTN number of the receiving party. When setting up an international call, the international prefix (e.g. in Finland 990 or 999) specific for each country is dialled first, and thereafter the country code, the national area code and the number of the receiving party are dialled in accordance with the ISDN numbering. When making a call from a telephone of the fixed network, no area code is dialled before the local telephone number. In other words, the user must dial different area codes in a mobile network and in a fixed network.

This causes problems particularly in a mobile network in which both standard mobile subscribers and WLL subscribers are located within the area of the same base station. In such a case, the mobile network should

be able to distinguish such local numbers of the subscribers that require different routing, that is, routing within the mobile network or routing in accordance with the PSTN numbering. The aim is that when a WLL subscriber dials a local call, it will be routed to the PSTN. If, again, the WLL subscriber wants to make a call to a mobile subscriber within the same mobile network, he should dial the area code of the mobile network before the subscriber number, as usual when making a call from the PSTN network, since a WLL terminal equipment is expected to behave in the same way as a PSTN terminal equipment.

Secondly, the user of a mobile network must press a specific 'send' key after dialling the directory number in order to activate call set-up, and an 'end' key when the call is terminated. There are no 'send' or 'end' keys in the telephone sets of the fixed network. In the fixed network, lifting the handset of the telephone (off-hook) activates a subscriber loop, which is detected in the exchange. As a result, the exchange generates a dialling tone to the subscriber loop. When the subscriber starts to dial the number of the called party, the exchange stops generating the dialling tone. If the call set-up fails or the called party is busy, the exchange will generate a busy tone to the subscriber loop. In the same way, the exchange also generates other signal tones to the subscriber loop.

There is thus need to implement the interface between a fixed telephone and a radio unit so that call set-up can be carried out in accordance with the call set-up in the fixed network as great to an extent as possible, that is, by employing the numbering scheme of the fixed network, avoiding the use of 'send' and 'end' keys, and supporting the analog signal tones of the

fixed network that indicate the proceeding of the call set-up to the user.

5 The European Patent Application 0 569 314
discloses an equipment for coupling one or more
conventional telephone sets to a cellular radio
network. The equipment comprises a radio unit for a
conventional telephone set. For making an outgoing call
the user off-hooks the handset, and the adapter
generates the dialling tone upon detecting that the
10 subscriber loop is closed. When he hears the dialling
tone, the user dials the directory number of the called
party. The dialling tone is switched off when the first
digit is being dialled. The equipment concludes the
dialling has terminated when a preset time has elapsed
15 without any further digits having been dialled.
Thereafter, call set-up to the radio network is
initiated. The call is terminated when the user on-
hooks the handset. Thus the telephone set of a fixed
network can be used in the conventional way, although
20 it is connected to a cellular radio network.

 U.S. Patents 4 658 096, 4 737 975, and 4 775
997 disclose an interface that connects a conventional
telephone set to a transceiver of a cellular radio
network. When the handset of the fixed network is on-
25 hooked, the interface system detects closing of the
subscriber loop, and generates a dialling tone. The
system converts the dialled tone-dial or pulse-dial
numbers, or digits into digital data for storage in the
transceiver. Once all the digits have been dialled, the
30 system automatically determines when the last digit has
occurred, and generates a send signal to the
transceiver. After receiving the send signal, the
transceiver transmits the telephone number that has
been converted into a bit sequence to the local
35 exchange, which decodes the number and routes the call

to the called party. In this system, the telephone set of a fixed network may also be used in the conventional way.

5 U.S. Patent 5 117 450 discloses a cellular radio telephone which is connected to a standard telephone set of a fixed network. The cellular telephone comprises a detector that monitors closing/opening of the subscriber loop, and once the subscriber loop is closed, generates a dialling tone.
10 A DTMF detector detects the numbers/digits dialled with a pushbutton telephone set, and codes them and stores them in the memory. If five seconds have elapsed from the last digit detected, the cellular telephone will check whether the dialled number can be accepted, that is, whether the dialled number contains enough
15 digits or whether it is a special directory number, such as an emergency number. If the dialled number is in an acceptable form, the stored directory number is transmitted to the cellular network and a call set-up is initiated.
20

In all of the prior art solutions disclosed above, the signalling connection over the radio path is not established until the entire directory number of the called party has been dialled and a preset time has
25 elapsed from the end of dialling. Thereafter, some time is required for establishing the signalling connection before the directory number of the called party can be sent to the exchange over the radio path. This is the reason for the delay typical of call set-up in a cellular radio network, and the delay is further
30 increased by the delay (up to 5 seconds) used for detecting the end of dialling. This delay does not occur in the call set-up of a fixed network. Therefore, the delay caused by call set-up should be minimized in
35 the WLL system in order that the WLL system would be as

similar to the fixed network as possible in this respect, as well.

5 The prior art solutions disclosed above do not take into account the incompatibility of the numbering schemes, such as area codes, between the fixed network and the cellular radio network either.

10 European Patent Application 0 530 010 discloses a radio telephone used in a multinational mobile telephone network, comprising an abbreviated dialling memory. The directory numbers can be inputted into the abbreviated dialling memory either in the format U+M+T or K+T, wherein U = international prefix, M = country code, K = national identifier, and T = trunk prefix + subscriber number. A country indicator
15 C is added to each dialled number, although a national number would be concerned. When a call is being established by means of an abbreviated number, the radio telephone will first check in which country it is currently registered to the network. If a number
20 retrieved from the memory and corresponding to an abbreviated number contains the country code of the current location country, it is recognized as a domestic call, and the number will be retrieved in the format K+T. If, instead, the country code of the
25 directory number retrieved from the memory is different from that of the current location country, the directory number will be retrieved in the format U+M+T, wherein U refers to the international prefix of the country in which the telephone is registered to the
30 network. Either international numbers or domestic numbers including their area codes can only be stored in the abbreviated dialling memory. The solution does not support dialling of a local number in call set-up carried out by means of a WLL system, in which it is
35 usually possible to dial international and domestic

long-distance calls only.

U.S. Patent 4 473 720 discloses an automatic dialler comprising a fixed part and a removable part. The fixed part contains location identifications, that is, the international prefix, the national identifier, the country code and the trunk prefix used at the location in question. The memory of the removable part contains the same parameters, as well as directory numbers to which the dialler may set up a call. As to their format, the directory numbers are local directory numbers, domestic long-distance numbers, or international long-distance numbers. When the removable part is connected to the fixed part, the dialler makes a comparison between the location identification parameters. If there are differences between the parameters, the dialler will modify the directory numbers in the memory of the removable part from local numbers into long-distance numbers in accordance with the parameters, and vice versa. The dialler is intended for a fixed network, and it is not suited for a WLL system, in which a call is established via a radio telephone network. It does not thus take into account the problem related to supporting the dialling of a local directory number in call set-up carried out via a radio network, whereby it is usually possible to dial domestic and international long-distance numbers only.

Disclosure of the Invention

An object of the present invention is to mitigate the problems disclosed above by shortening the call set-up time in a WLL system and by eliminating the incompatibility between the numbering scheme in the fixed network and in the radio network.

The invention relates to a radio unit for connecting a subscriber station of a fixed network, such as a telephone set, to the radio network of a WLL

system, comprising means for detecting the off-hook and on-hook states of said subscriber station; means for generating signal tones to said subscriber station; a detector for detecting dialling digits received from said subscriber station, such as the digits related to the directory number of a called party; the radio unit being arranged to buffer the detected digits of the called party directory number for sending them to the radio network after the dialling has ended. The radio system is characterized in accordance with the invention by being arranged to initiate connection and call set-up in the radio network in response to detecting the first dialling digit or digits.

The invention further relates to a method for establishing a call from a fixed subscriber station, such as a telephone set, which is connected to the radio unit of the radio system of a WLL system, comprising the following steps: a user of the fixed subscriber station dialling the directory number of the called party, said directory number consisting of several digits; the radio unit detecting said dialling digits of the called party directory number received from the fixed subscriber station; the radio unit buffering said dialling digits until the end of dialling; the radio unit sending the directory number of the called party to the radio network after the end of dialling. In accordance with the invention, the method is characterized by the radio unit initiating connection and call set-up in the radio network immediately after detecting the first dialling digit or digits before the end of dialling.

The invention further relates to a WLL system comprising a radio network, and a radio unit by means of which the fixed subscriber station, such as a telephone set, is connected to the radio network, the

radio unit comprising means for detecting the off-hook and on-hook states of the fixed subscriber station; means for generating signal tones to the fixed subscriber station; a detector for detecting the dialling digits received from the fixed subscriber station, such as the digits related to the directory number of the called party; the radio unit being arranged to buffer the detected digits of the called party for sending them to the radio network after the end of dialling. In accordance with the invention, the system is characterized in that the radio unit is responsive to detecting the first dialling digit or digits for initiating connection and call set-up in the radio network by means of a call set-up command which does not contain the directory number of the called party; the radio network is arranged to initiate call set-up only after checking from the subscriber data that the call set-up commands of the subscriber station are accepted without the directory number of the called party; the radio unit is arranged to send the directory number of the called party to the radio network in an address message later during call set-up when dialling has ended; the radio network is arranged to initiate call routing in accordance with the directory number of the called party upon receiving said address message.

In the invention, the radio unit to which a fixed subscriber station is connected initiates connection and call set-up in the radio network immediately when the first digit or character of the directory number of the called party is dialled from the subscriber station. Thus, the directory number of the called party can be dialled simultaneously when the call set-up procedures of the radio network establish a signalling connection between the radio unit and the

exchange. The radio unit buffers the digits of the dialled directory number until the end of dialling. When the dialling has ended, the radio unit sends the directory number of the called party to the radio network. The dialling can be assumed to have ended when a preset time has elapsed from detecting the last digit, or when a preset digit indicating the end of dialling is detected. When the end of dialling is concluded on the basis of the time that has elapsed from the last digit, which time may be several seconds, there is a risk of losing the time benefit that is gained from simultaneous set-up of a signalling connection and dialling. The call set-up time can be maintained in its minimum if the subscriber indicates the end of dialling himself by pressing a preset key, such as '#'. If both the ways disclosed above are used simultaneously for detecting the end of dialling, it is possible to gain time benefit from fast call set-up, but also ensure continuation of call set-up in a situation in which the user forgets to dial the character indicating the end of dialling. In a preferred embodiment of the invention, in addition to setting up the signalling connection, the actual call set-up is also initiated prior to the end of dialling by sending from the radio unit to the radio network a call set-up message which does not contain the directory number of the called party. On account of this solution, the call set-up time may be shortened more than by means of the mere simultaneous dialling and establishing of the signalling connection. If solely dialling and establishing of the signalling connection are carried out simultaneously, the call set-up message will not be sent until the entire directory number has been dialled, which results in another, relatively long delay before the call is

established. If, again, part of the procedures related to call set-up are carried out already during dialling, and if the directory number is sent later in a separate address message, the delay typically associated with the call set-up of a cellular radio network may further be minimized.

Supporting the local number of the fixed network may be carried out as follows in accordance with a preferred embodiment of the invention. The mobile services switching centre automatically routes to the PSTN the local numbers contained in the address message. In other words, the mobile services switching centre directly concludes from the use of the address message that a WLL subscriber is concerned and that the local numbers refer to PSTN numbers. On account of this solution, a WLL subscriber can dial a directory number in accordance with the numbering scheme employed in a fixed network, but the routing procedure carried out by the exchange may be maintained unchanged e.g. in the GSM system. In other words, mobile subscribers employ a standard call set-up procedure and a standard call set-up message.

Brief Description of The Drawings

In the following, the invention will be disclosed in more detail by means of the preferred embodiments with reference to the attached drawings, in which

Figure 1 shows a WLL radio system in accordance with the invention,

Figure 2 is a block diagram illustrating a WLL subscriber station of the invention, comprising a telephone set 14 of a fixed network, an adapter, and a terminal equipment MS of a radio network,

Figure 3 is a signalling diagram illustrating the standard call set-up signalling of the GSM system.

in a case of an outgoing call,

Figure 4 is a signalling diagram illustrating the call set-up signalling in accordance with the invention in a case of an outgoing call,

5 Figure 5 is a flow chart illustrating the operation of the adapter 10 in accordance with the invention in call set-up of an outgoing call,

10 Figure 6 is a flow chart illustrating the operation of the MS in call set-up of an outgoing call in accordance with the invention,

Figure 7 shows the "number of the called party" -structure of the information element of the SETUP message, and

15 Figure 8 shows the structure of the ADDRESS message in accordance with the invention.

Preferred Embodiments of The Invention

The present invention may be applied in any radio system which is used for implementing a wireless subscriber connection of a Wireless Local Loop system (WLL) by replacing the cabled subscriber lines between
20 a fixed telecommunications network, such as a telephone network, and its subscribers. The attached Figure 1 shows the principle of a WLL system in accordance with the invention, based on the use of prior art radio
25 networks, such as GSM. The WLL system may be carried out as a part of a conventional mobile communications network, whereby there may be both WLL subscribers and mobile subscribers in the same network. In the following, the invention will be disclosed by way of
30 example with reference to a WLL network based on the pan-European digital mobile communications network GSM, without being restricted thereto, however.

35 The radio system shown in Figure 1 comprises a mobile services switching centre MSC, a base station controller BSC, base stations BTS, and a WLL subscriber

station 3, 4. For the sake of clarity, Figure 1 only shows one base station controller, two base stations and one subscriber station, but there are naturally many of them in a real network. The MSC comprises, like
5 a conventional radio telephone exchange, a switch for switching the calls, and a call control computer for controlling all the signalling between the subscriber stations and the radio network during call set-up, conversation, and call termination, and allocates radio
10 channels to the calls for radio connections between the BTS and the subscriber stations 3, 4. The MSC of the radio system is also connected 5 to a public switched telephone network PSTN 2, and further to PSTN subscribers 1, as well as other networks 10 and their
15 subscribers. The MSC may be implemented directly as a local exchange of the PSTN network. The BTS may also be implemented in the same way as a conventional base station. Its basic unit naturally consists of a plurality of transceivers, whose exact number is
20 determined according to the required traffic capacity.

A WLL subscriber station typically comprises a radio unit 3, and a conventional subscriber station of a fixed network, such as a telephone set 4, a telefax machine, a data modem, or the like. The radio
25 unit 3 operates as an interface unit towards the radio path and provides the user with a standard analog two-wire subscriber line, to which the user can connect his conventional telephone set 4. The structure of the radio unit will be disclosed in closer detail below in
30 connection with Figure 2.

A WLL subscriber station typically has a fixed location within the WLL system. Therefore, the MSC of the WLL system connects the directory number of the subscriber station to the location area formed by a
35 base station BTS or a number of base stations within

the coverage area of which the subscriber station is located. When there is a terminating call to the subscriber number, the MSC starts paging of the subscriber station via the radio path only in the area of the BTS in question or in the location area in question. Since the subscriber is assumed to be in a fixed position, neither mobility management functions nor location updating are required in the WLL system, although these functions are a part of a standard mobile communications network. The radio system, however, must comprise at least one subscriber data base, such as a visitor location register VLR connected to the MSC, for maintaining subscriber data on the subscribers located within the area of the MSC.

Figure 2 shows a radio unit 3 in accordance with the invention comprising a terminal equipment of the radio system MS and an adapter 10. The adapter 10 provides a conventional analog two-wire PSTN subscriber line interface 11 for connecting a PSTN subscriber station, such as a telephone set 4. A DC source voltage 12 generates the direct voltage (e.g. 12 V, 24 V, or 48 V) required for the subscriber loop in the subscriber line interface. An OFF/ON HOOK detector 13 detects closing of the subscriber loop when the user off-hooks the handset (OFF HOOK), and opening of the subscriber loop when the user on-hooks the handset (ON HOOK). A signal tone generator 14 generates the signal tones required for the subscriber line interface 11, indicating the different stages of the call to the user. These signal tones include e.g. a dialling tone, a busy tone, a ringing tone, etc. A ringing voltage generator 16 generates a ringing voltage to the subscriber line interface 11 for providing a ringing signal to the telephone set 4 in the case of an incoming call. A detector 15 detects dual-tone

15

multifrequency (DTMF) dialling digits in the binary format for further processing that takes place in a controller 16. Detector 15 may also be a pulse dial detector if the telephone set 4 employs pulse-dialling.

5 All of the blocks 11 - 16 may be implemented in the ways known per se, and the examples of practical implementations are disclosed e.g. in U.S. Patents 4 737 975 and 5 117 450. The adapter 10 further comprises a microcontroller 17, to which the outputs of detectors

10 13 and 15 are inputted for further processing, and which controls the operation of the signal tone generator 14 and the ringing voltage generator 16. The controller 17 comprises a control interface 22, through which it transmits the dialling digits and control

15 signals to the radio unit MS, and receives control signals from the radio unit MS.

The radio unit MS provides a radio connection to the BTS of the radio network, and all the signalling related to the radio connection with the radio system.

20 The radio unit MS is advantageously a terminal equipment of the radio system on which the implementation of the WLL system is based. In the case disclosed in the example, the radio unit MS is a terminal equipment of the GSM system, and it has been

25 modified for the operation in accordance with the invention, as will be disclosed below. In the block diagram shown in Figure 2, the radio unit MS only comprises the basic components essential to describing the invention. A transceiver block 18 comprises a radio

30 transmitter and a receiver, modulation and detection, interleaving and deinterleaving, channel coding and channel decoding, speech coding, speech decoding, etc. An audio/data port 24 of the transceiver 18 is connected to the subscriber line interface 11 of the

35 adapter 10. The transceiver 18 modulates an audio/data

signal received at the port 24 onto the radio frequencies, and transmits the RF signal via an antenna 21 to the base station BTS. Accordingly, the transceiver 18 demodulates the radio-frequency signal received from the BTS into a baseband audio/data signal, which is applied via the port 24 to the subscriber line interface 11. The operation of the radio unit MS is controlled by a microcontroller 20. Controller 20 generates signalling messages, which are sent via the transceiver 18 to the radio system, and decodes the signalling messages received from the radio system via the transceiver 18. Controller 20 is connected to the controller 17 of the adapter 10 by means of a control interface 22, via which the dialling digits and the control signals are transmitted. In addition, a buffer memory 25 for temporary storage of the dialling digits, as well as a timer 23 for detecting the end of dialling are connected to the controller 20, as will be explained below.

Figure 3 is a signalling diagram illustrating signalling commands in call set-up carried out at the subscriber end in accordance with the GSM recommendations 04.08, version 4.7.0. As stated above, this signalling is not initiated in mobile communications systems until the number of the called party is dialled by pressing the 'send' key. This causes a call set-up delay typical of mobile communications networks. In prior art solutions, in which a fixed telephone is connected to a terminal station of a mobile communications system, setting up a signalling connection and a call is also initiated only after a preset time has elapsed from the end of dialling. The combined effects of these factors have resulted in a remarkably long delay in call set-up. In the invention, the call set-up delay is shortened by

initiating call set-up immediately after the first dialling digit has been detected. Furthermore, the SETUP command is divided into two parts in accordance with the invention for further shortening the call set-up delay. Call set-up in accordance with the invention will be explained in the following in closer detail with reference to drawings 4 - 8.

Figure 5 is a flow chart illustrating the operation of the adapter 10 shown in Figure 2. The detector 13 in the adapter 10 monitors closing (OFF HOOK) and opening (ON HOOK) of the subscriber loop in the subscriber line interface 11 (step 501). When the handset 4 of the telephone is off-hooked, the subscriber loop is closed (OFF HOOK), and the controller 17 commands the signal tone generator 15 to generate a dialling tone to the subscriber line interface 11 (step 502). Thereafter, it is waited that the user of the telephone set 4 dials the first dialling digit (number or symbol) in step 503. When the detector 15 detects the first DTMF digit and outputs the corresponding binary value to controller 17, controller 17 will generate a "send" signal (step 504) to the controller 20 of the radio unit MS. Simultaneously, the first detected digit is transferred to controller 20. Thereafter, it is waited for the reception of the second dialling digit (step 505). Once controller 17 has received the second dialling digit, it will forward the digit to controller 20 and reset the timer 23 (step 506) that measures the time that has elapsed from receiving the second digit. In step 507, controller 17 checks whether a new dialling digit has been received. If that is not the case, controller 17 will check whether the reading on the timer 23 has reached the predetermined delay-time T1 (step 508). If that is not the case, it is returned to step 507. In

case the timer 23 has reached the predetermined delay-time T1, that is, time T1 has elapsed from dialling the last digit, controller 17 assumes the dialling has ended, and generates a signal "end of dialling" to the controller 20 of the radio unit.

If the controller receives a new digit in step 507, it will check whether the digit is a specific predetermined symbol dialled by the user for indicating the end of dialling (step 509). The use of the "end of dialling" symbol provides the maximum benefit from carrying out establishing of the signalling connection and the call simultaneously with dialling (after step 504). In a case where only the time elapsed from dialling the previous digit is measured, a remarkable part of the benefit gained from simultaneous call set-up will be lost. However, a preferred embodiment of the invention comprises, besides the "end of dialling" symbol, a timer 23 for ensuring that call set-up is started after time T1 at the latest if the user forgets to dial the "end of dialling" signal. In the preferred embodiment of the invention, the "end of dialling" symbol is represented by the character "#". The character "#" is the most appropriate for that purpose as it does not occur in directory numbers, and it only occurs as the first or the second digit, or as the last digit in supplementary services commands. In the invention, the check of the "end of dialling" symbol is only carried out for the third digit and the subsequent digits, whereby "#" in the first or the second digit will not cause any problems. If a supplementary services command ends with the symbol "#", there is no need to dial the symbol twice.

If the digit checked in step 509 is not the character "#", controller 17 will forward the digit to controller 20 and return to step 506. Controller 17

will continue in the loop (506, 507, 508 and 509) receiving new digits until the timer 23 expires or the end character "#" is received.

Figure 6 is a flow chart illustrating the operation of the radio unit MS in accordance with the invention in call set-up of an outgoing call. In step 601 in Figure 6, the controller 20 of the radio unit waits for the "send" signal from the controller 17 of the adapter 10. When the controller 20 receives the "send" signal via a control line 22, it will immediately initiate a procedure for establishing a signalling connection and a call (step 602). These procedures include signalling between the radio unit and the radio network in accordance with the GSM recommendation 04.08, version 4.7.0, as illustrated in Figure 4. In a case of successful call set-up, the signalling consists of the following messages: "Channel request", "Immediate assignment", "CM Service request", "Authentication request", "Authentication response", "Cipher mode command", "Cipher mode complete" prior to the SETUP message. As far as the SETUP message is concerned, the invention deviates from signalling disclosed in the GSM recommendation 04.08. In accordance with the GSM recommendation, the directory number of the called party is sent to the MSC in said SETUP message, which is also used for sending information on the requested service in a Bearer capability information element, which is defined in the GSM recommendation 04.08, version 4.7.0, Figures 10.71 - 10.79. In accordance with the invention, since the call set-up signalling is started in the case of a WLL subscriber station from the Channel request message immediately after the dialling of the first digit, it is probable that when signalling has proceeded to the step of sending the SETUP message, the subscriber

number of the called party has not been completely dialled, and it is thus not known yet. The information on the requested service is available, however, in a case of a normal call, as the information on the "Bearer capability" parameters of the WLL subscriber station is stored in the GSM subscriber station, i.e. the radio unit. If the WLL subscriber station comprises more than one interface, e.g. separate interfaces for speech and data, the "Bearer capability" parameters may be configured individually for each interface. The radio unit thus chooses the "Bearer capability" parameters for the SETUP message in accordance to which interface the WLL terminal is using. It can be concluded on the basis of the very first dialled symbol whether it is a question of a normal call or a supplementary services command. If the first character (digit) is a number, it is a question of a normal call.

Thus, it is possible to include all the other information specified in the GSM recommendations, except for the directory number of the called party, in a SETUP command in accordance with the invention. The directory number of the called party is normally transmitted in a "Called party BCD number" information element in accordance with the GSM recommendation 04.08, version 4.7.0, Figure 10.73. Said information element is also shown in Figure 7. The length of the information element is at least 3 octets, and 13 octets at the most. The number of the called party is normally transmitted in octets 4 - 13. The number of the called party may be omitted from this information element when octets 4 - 13 are entirely omitted, and the value of the type field is set to 000 (unknown), and the numbering scheme identifier to 0000 (unknown). These definitions comply with the GSM recommendations, and they are disclosed in the GSM recommendation 04.08,

version 4.7.0, Table 10.81.

Referring to Figure 4, the SETUP message is followed by the following messages in accordance with the GSM recommendation: "Call proceeding", "Assignment command", and "Assignment complete", at which stage a traffic channel has already been reserved for the connection between the radio unit MS and the MSC.

Simultaneously with the signalling procedure described above, the controller 20 of the radio unit receives dialling digits from the adapter 10 one at a time (Figure 6, step 603), records the digit into the buffer memory 25 (step 604), and checks whether an "End of dialling" signal has been received from the adapter 10 (step 605). The controller 20 continues in the loop (603, 604, 605) until all the digits have been received and stored, and the adapter 10 has sent the "end of dialling" signal. In step 606 the number of the called party is sent to the MSC in a specific "Address command" message. Said "Address command" message is sent in accordance with the signalling diagram of Figure 4 after a traffic channel has been reserved for the connection between the radio unit MS and the MSC. Thus, it has been possible to carry out dialling, as well as to establish of the connection and the call simultaneously, which remarkably cuts down the call set-up delay typical of the mobile communication system. It must be noted that the "Address command" message is not sent if it is a question of a supplementary service command instead of normal call set-up.

Figure 8 shows a possible structure for the "Address command" message. The "Address command" message shown in Figure 8 is similar to the "SETUP" message, which is defined in the GSM recommendation 04.08, version 4.7.0, Table 9.70a, except for

containing only two information elements: a "Called party BCD number" information element in accordance with the GSM recommendation 04.08, version 4.7.0, Figure 10.73, and a "Called party subaddress" information element in accordance with Figure 10.74. The latter information element is optional, and required in some special cases only. In addition, the "Address command" message contains a call control protocol discriminator = 0011, a transaction identifier = 0xxx (wherein the x's are defined by the radio unit MS), as well as a separate message type, which is defined to have the similar structure as the other call set-up messages, that is 0x001100 (GSM recommendation 04.08, version 4.7.0, Table 10.3). In the figure, IEI represents the indicator of the information element.

The MSC is arranged to initiate call routing to the called party in accordance with the called party subscriber number after receiving the "Address command" message described above. In addition, in the signalling between the radio unit MS and the radio network, the standard messages for finishing the call set-up in accordance with the GSM recommendations are sent after the "Address command" message: "Call proceeding", "Alerting", "Connect", "Connect acknowledge", as shown in Figure 4.

In normal call set-up carried out from a fixed subscriber station, it is usually possible to dial international and domestic long-distance numbers only. Supporting the local number of the fixed network may be carried out in accordance with the preferred embodiment of the invention as follows: The MSC automatically routes all the local numbers contained in the "Address command" message to the PSTN. In other words, the MSC concludes directly from the use of the "Address command" message that a WLL subscriber is concerned and

that the local numbers refer to PSTN numbers. Normal mobile subscribers employ a standard call set-up procedure and a standard call set-up message. Thus, the MSC may conclude on the basis of the call set-up message that a mobile subscriber is concerned and that the local numbers refer to internal numbers within the mobile network. On account of this solution, the WLL subscriber may dial the directory number in accordance with the numbering scheme employed in the fixed network, but the routing procedures carried out by the MSC may be maintained unchanged e.g. in the GSM system.

Finally, a special case will be discussed, in which a number dialled from the subscriber station 4 has started with some other character than a number, that is, it is a question of a supplementary services command. In such a case, call set-up is started in the same way as in Figure 4 immediately after the first digit (character) has been detected in the adapter 10, and the "Send" signal has been generated, but, thereafter the SETUP, "Facility", or "Register" message related to the supplementary services is sent from the radio unit MS to the MSC only after controller 20 has received an "end of dialling" signal from the adapter 10. This is done as it is not known which supplementary service is in question before the entire string of characters has been dialled. The last digit of the supplementary services commands is always "#", whereby the digit must be stored along with the other digits of the supplementary services command, as well as generate the "end of dialling" signal. In addition, since a supplementary services command must always end with the digit "#", the "end of dialling" signal cannot be initiated by means of time supervision. Time supervision can be used only for ensuring interrupting the call set-up if the user interrupts the dialling

before the end digit "#". No "Address command" messages are thus not sent along with supplementary services commands. The SETUP message, in turn, contains a so-called Facility information element, which is disclosed in the recommendation GSM 04.08, version 4.7.0, subsection 10.5.4.15. Furthermore, it is possible to determine in the MSC whether it will signal information on the supplementary services configuration further to the exchange of the PSTN network, or whether it will store the information in its own database.

The attached figures and the explanation related thereto are only intended to illustrate the present invention. Although the invention has been explained with reference to specific embodiments, it is to be understood that the explanation is only made by way of example, allowing alterations and modifications without deviating from the scope and the spirit of the invention disclosed in the attached claims.

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Claims

1. A radio unit for connecting a subscriber station (4) of a fixed network, such as a telephone set, to the radio network of a WLL system, said radio unit (10, MS) comprising
- 5 means (13) for detecting the off-hook and on-hook states of said subscriber station;
- means (14) for generating signal tones to said subscriber station;
- 10 a detector (15) for detecting dialling digits coming from said subscriber station, such as the digits related to the directory number of a called party;
- the radio unit being arranged to buffer the detected digits of the called party directory number for sending them to the radio network after the dialling has ended,
- 15 c h a r a c t e r i z e d in that
- the radio unit is arranged to initiate connection and call set-up in the radio network in response to detecting the first dialling digit or digits.
- 20 2. A radio unit as claimed in claim 1, c h a - r a c t e r i z e d by
- 25 comprising a timer (23) for measuring the time that has elapsed from detecting the last dialling digit,
- being arranged to send the digits of the called party directory number to the radio network when the time measured by the timer (23) reaches a predetermined time.
- 30 3. A radio unit as claimed in claim 1 or 2, c h a r a c t e r i z e d by being arranged to send the digits of the called party directory number to the radio network immediately when the third dialling digit
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or any one of the subsequently detected dialling digits is a predetermined dialling digit.

4. A radio unit as claimed in claim 1, 2 or 3, characterized by

5 being arranged to initiate call set-up in the mobile communications network with a call set-up command (Figure 7) which does not contain the directory number of the called party,

10 being arranged to send the directory number of the called party in an additional address message (Figure 8) after the end of dialling.

5. A method for setting up a call from a fixed subscriber station, such as a telephone set, which is connected to the radio unit of the radio network of a WLL system, comprising the following steps:

15 the user of the fixed subscriber station dialling the directory number of the called party, the directory number consisting of several digits,

20 the radio unit detecting said dialling digits related to the called party directory number, received from the fixed subscriber station,

the radio unit buffering said dialling digits until the end of dialling,

25 the radio unit sending the directory number of the called party to the radio network after the end of dialling, characterized by

30 the radio unit initiating connection and call set-up in the radio network immediately after detecting the first dialling digit or digits prior to the end of dialling.

6. A method as claimed in claim 5, characterized by

the radio unit measuring the time elapsed from detecting the last digit,

35 the radio unit assuming the dialling has ended

when the time measured reaches a predetermined time.

7. A method as claimed in claim 5 or 6,

characterized by

5 dialling a predetermined digit by a user to
indicate the end of dialling,

 the radio unit sending the directory number of
the called party to the radio network immediately if
the third digit or any one of the subsequent dialling
digits is said predetermined digit.

10 8. A method as claimed in claim 5, 6 or 7,

characterized by

 the radio unit initiating a call set-up in the
radio network with a call set-up command which does not
contain the directory number of the called party,

15 the radio network initiating a call set-up
only after checking from the subscriber data that the
call set-up commands of the subscriber are accepted
without the directory number of the called party,

 the radio unit sending the directory number of
20 the called party to the radio network in an address
message later during call set-up when dialling has
ended,

 the radio network initiating a call routing
according to the directory number of the called party
25 upon receiving said address message.

9. A method as claimed in claim 8, characterized by

 recognizing the local numbers in the address
message as local numbers of the fixed telephone network
30 and routing the call to the fixed network.

10. A method as claimed in claim 8 or 9, characterized in that

 the call set-up command is a SETUP message in
accordance with the GSM recommendation 04.08, wherein
35 the digits related to the directory number of the

called party are omitted from the Called party BCD number information element, and the value of the type field, as well as the value of the numbering plan identifier are set to unknown,

5 the address command contains at least the following information elements included in a SETUP message in accordance with the GSM recommendation 04.08: Call control discriminator, Transaction identifier, Message type, Called party subaddress.

10 11. A WLL system comprising a radio network and a radio unit (10, MS), by means of which a fixed subscriber station (1), such as a telephone set, is connected to the radio network, the radio unit comprising

15 means (13) for detecting the off-hook and on-hook states of the fixed subscriber station,

 means (14) for generating signal tones to the subscriber station (1) of the fixed network,

20 a detector (15) for detecting the dialling digits, such as digits related to the directory number of the called party received from the fixed subscriber station (1),

 the radio unit being arranged to buffer (23) the detected digits of the called party for sending them to the radio network (BTS, BSC, MSC) after the end of dialling, c h a r a c t e r i z e d in that

25 the radio unit is responsive to detecting the first dialling digit or digits for initiating connection and call set-up in the radio network with a call set-up command (Figure 7) which does not contain the directory number of the called party,

30 the radio network is arranged to initiate call set-up only after checking from the subscriber data (VLR) that the call set-up commands of the subscriber station are accepted without the directory number of

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the called party,

the radio unit is arranged to send the directory number of the called party to the radio network in an address message (Figure 8) later during call set-up after the end of dialling,

the radio network is arranged to initiate call routing in accordance with the directory number of the called party upon receiving said address message.

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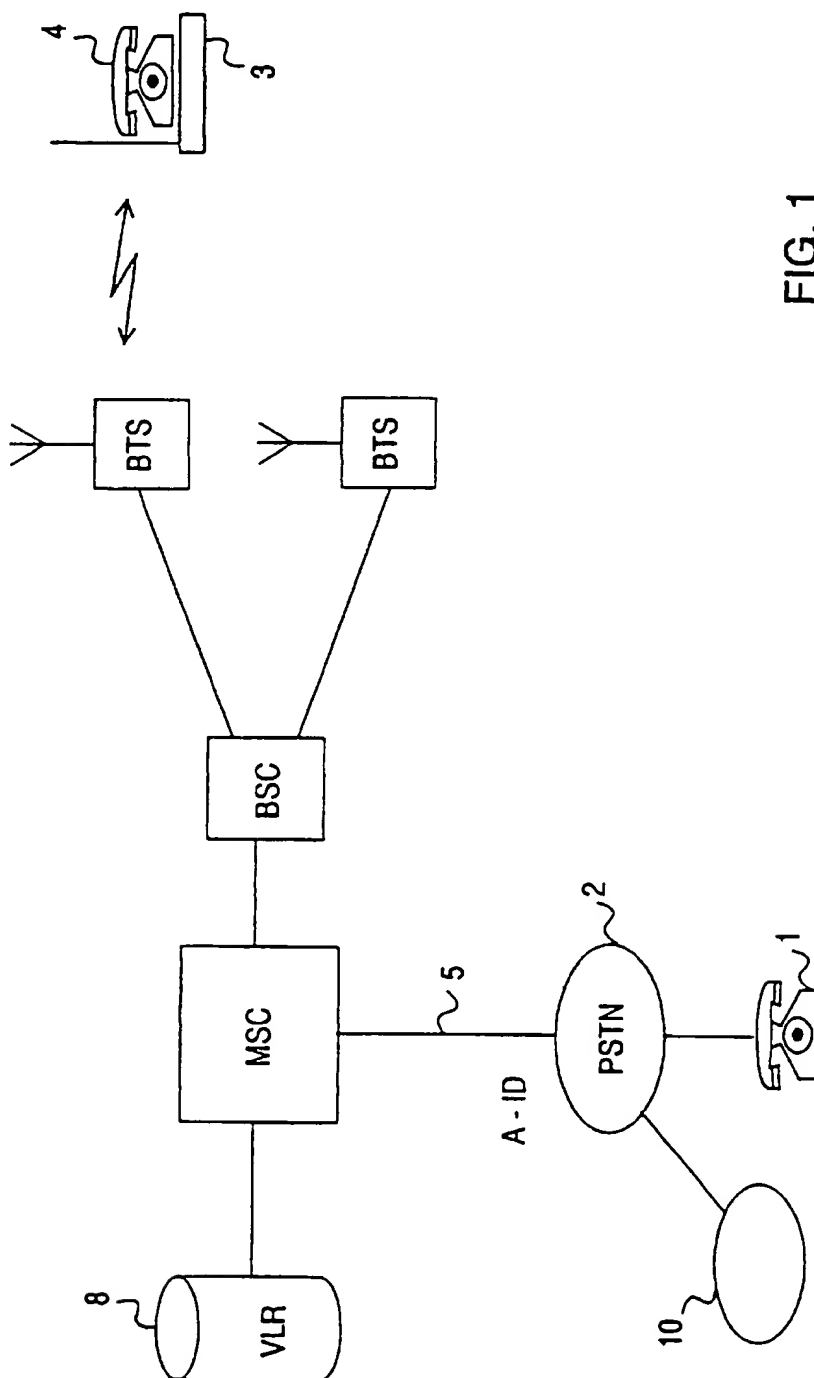


FIG. 1

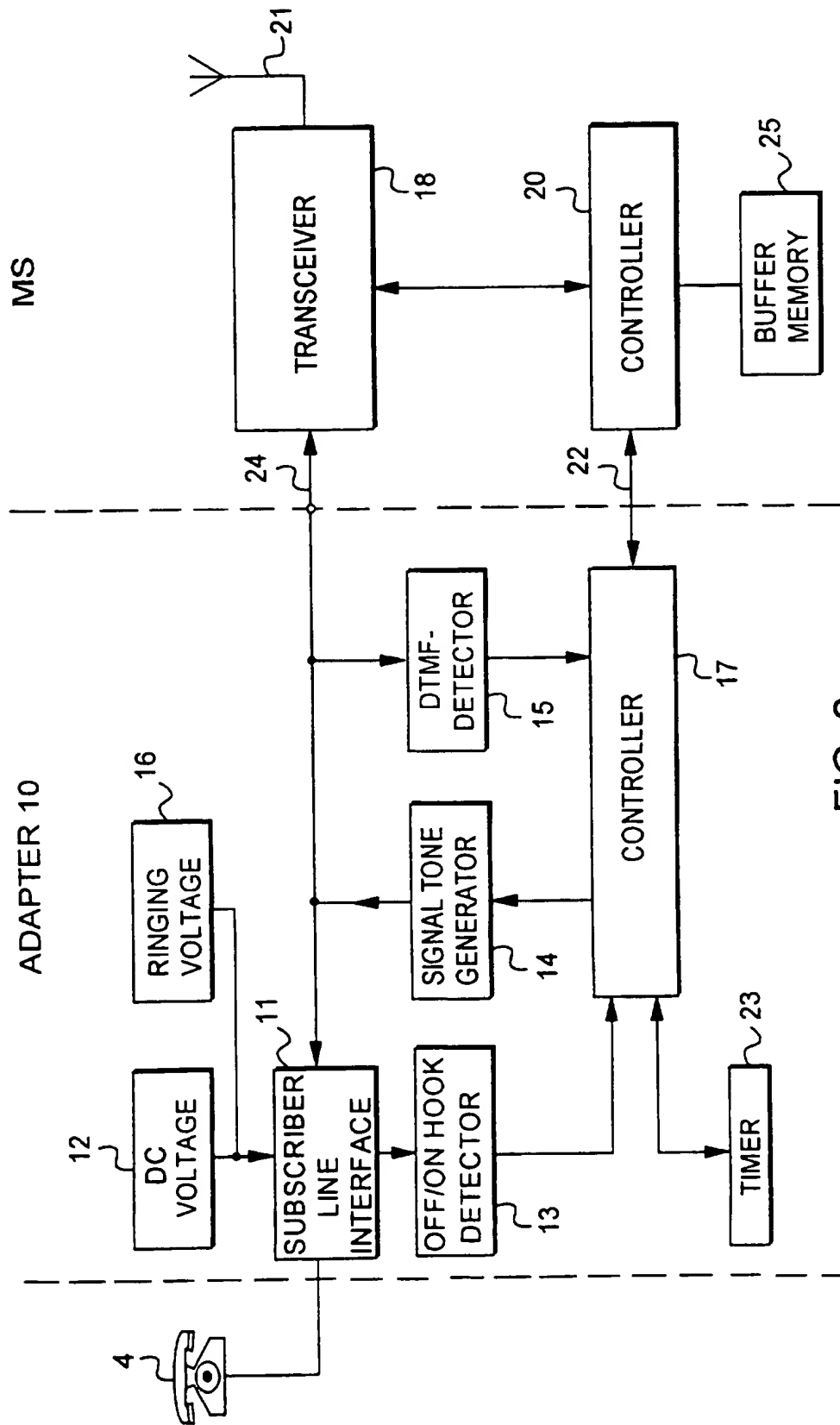


FIG. 2

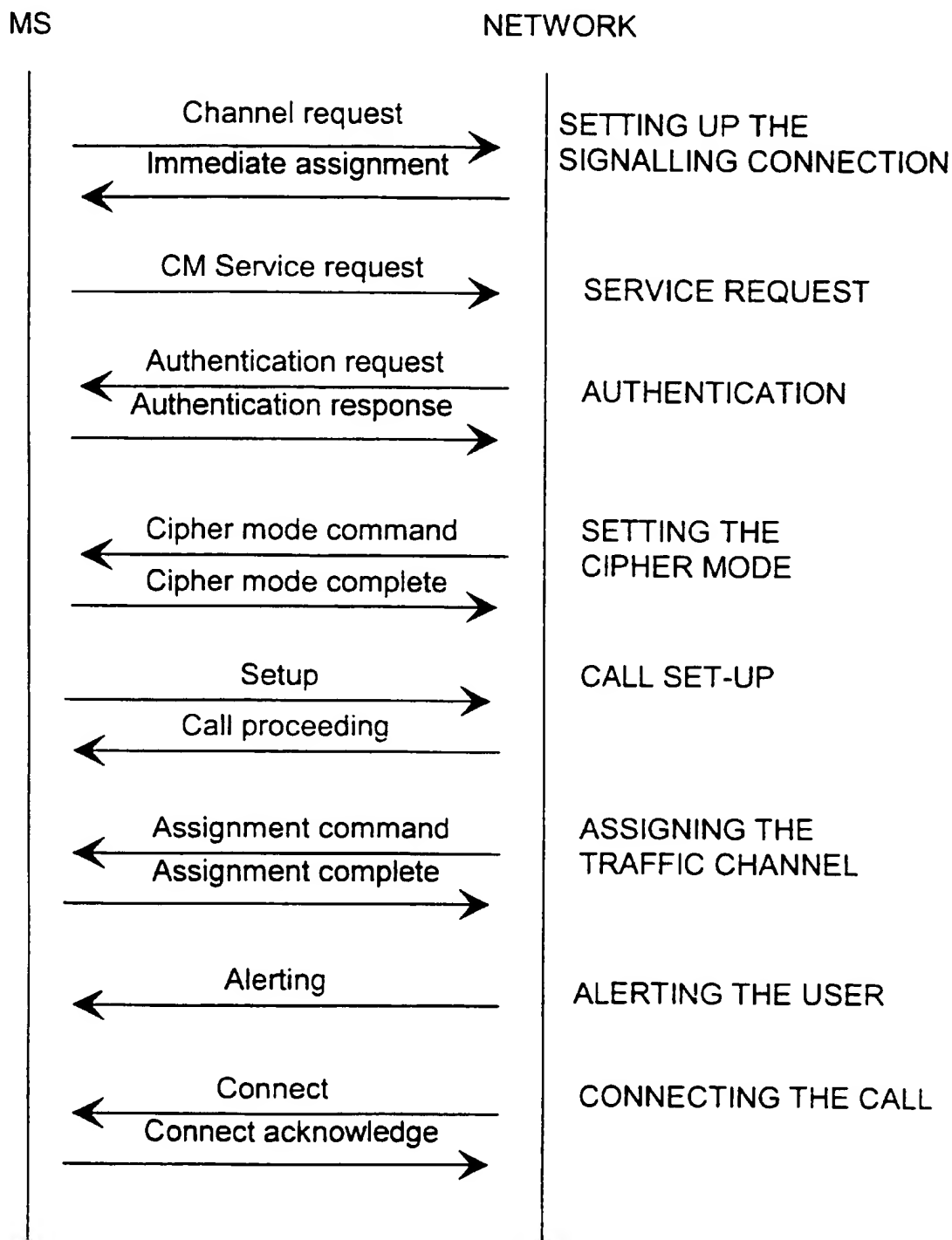


FIG. 3

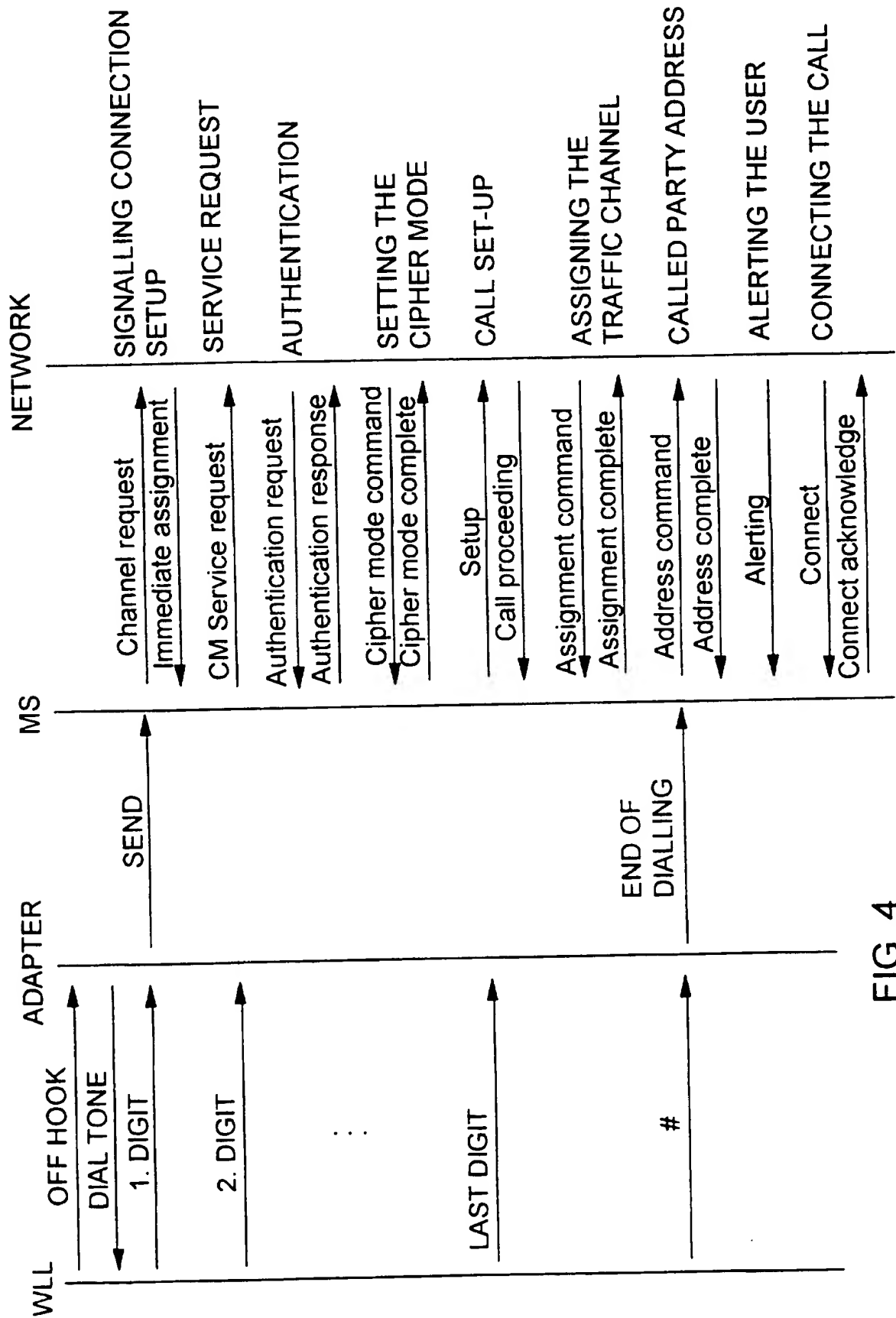


FIG. 4

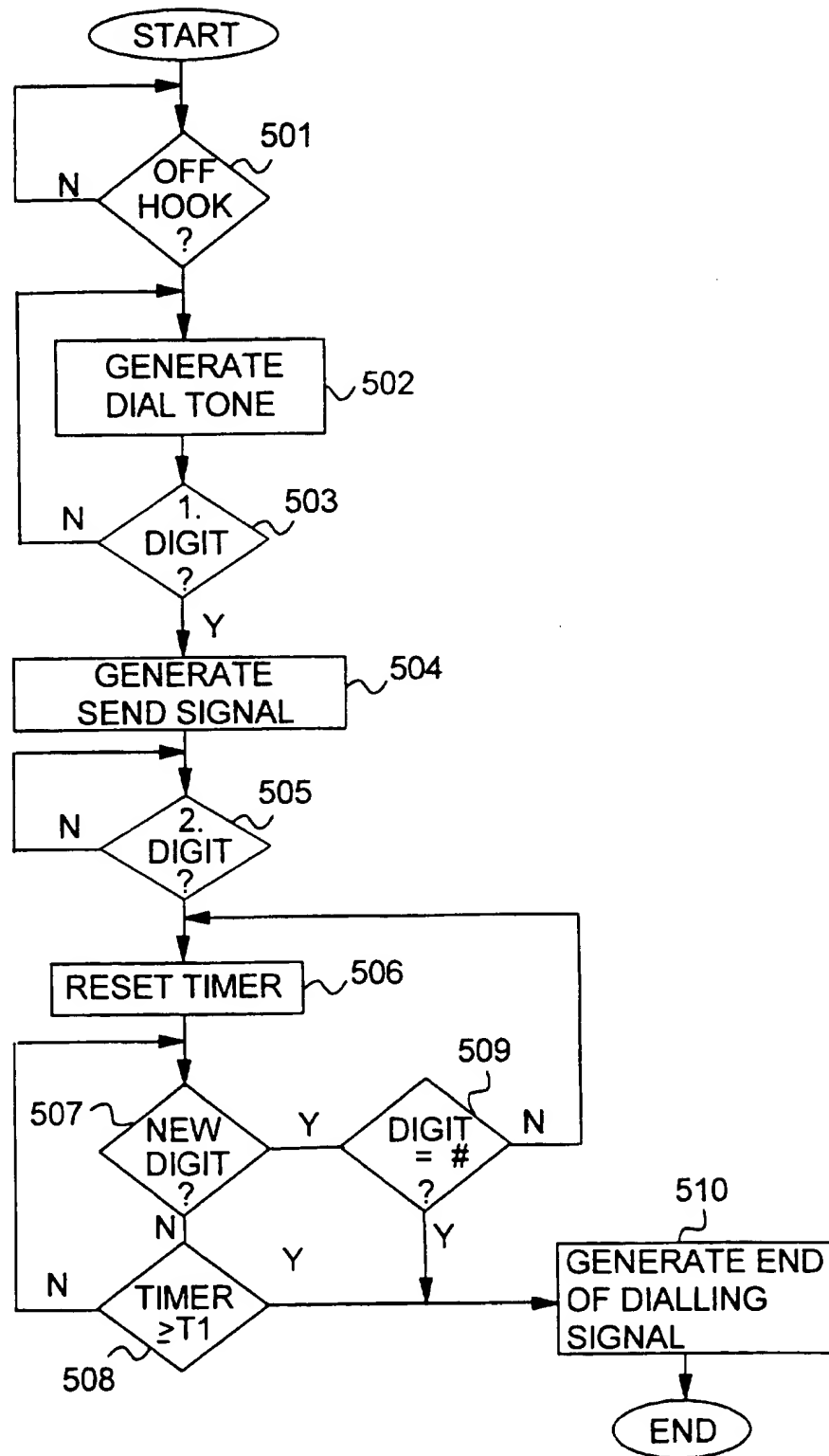


FIG. 5

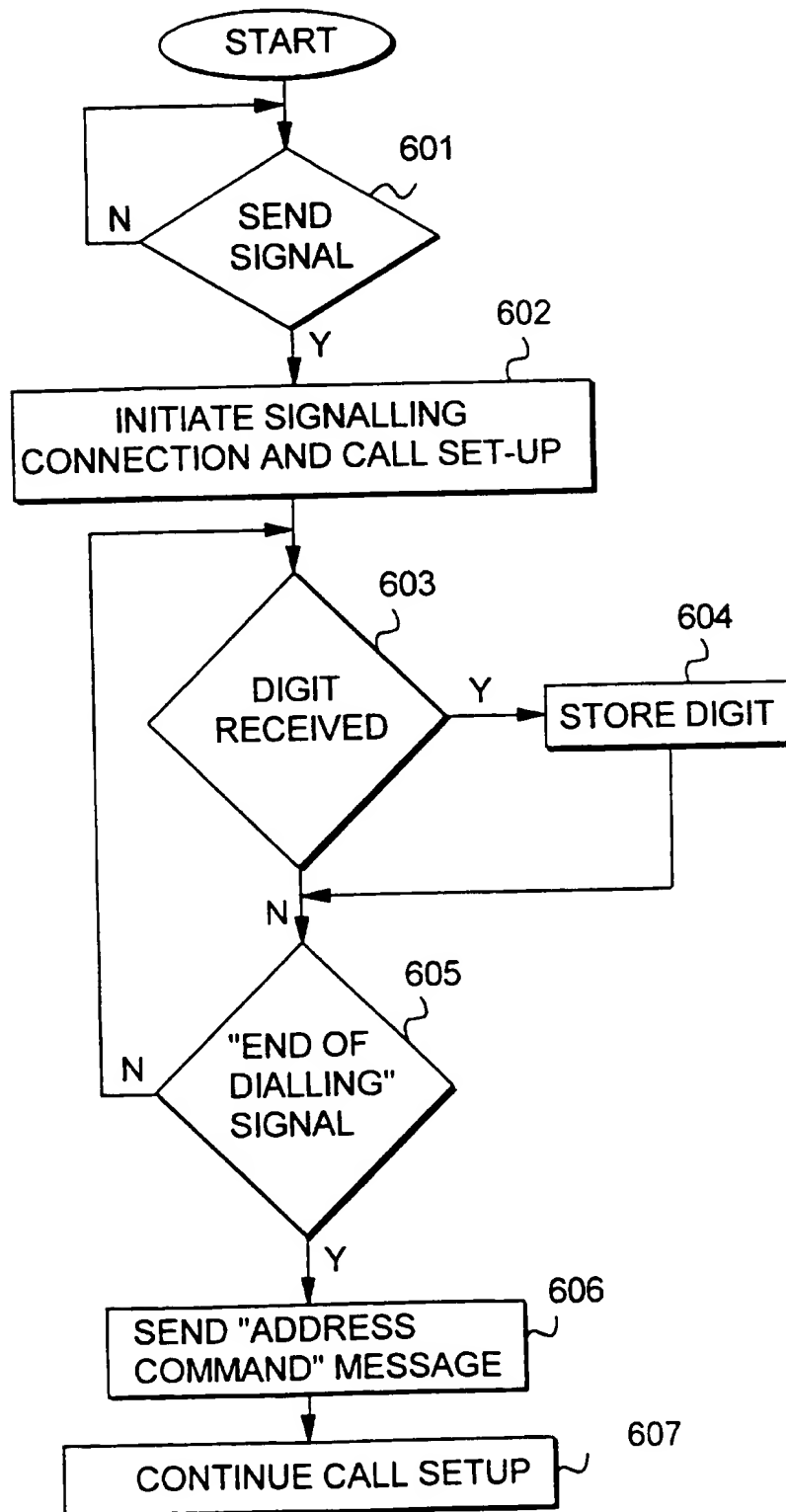


FIG.6

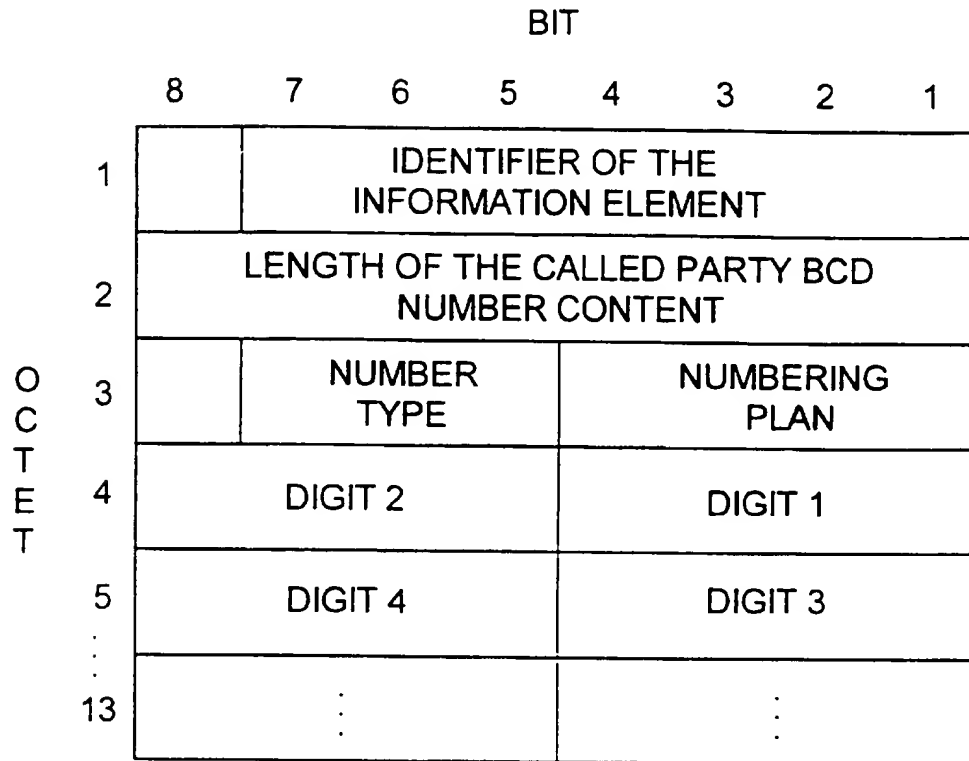


FIG. 7

IEI	INFORMATION ELEMENT
	CALL CONTROL PROTOCOL DISCRIMINATOR = 0011
	TRANSACTION IDENTIFIER=0XXX (DETERMINED BY THE MS)
	MESSAGETYPE = 0X001100
5E	CALLED PARTY BCD-NUMBER
6D	CALLED PARTY SUBADDRESS (OPTIONAL)

FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 96/00185

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H04Q 7/32, H04Q 7/20

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 9506995 A1 (BELL SOUTH INTERNATIONAL, INC.), 9 March 1995 (09.03.95), page 8, line 2 - line 26; page 22, line 19 - page 25, line 6 --	1-11
A	WO 9014729 A1 (MOTOROLA, INC.), 29 November 1990 (29.11.90), page 3, line 11 - line 22; page 5, line 1 - page 6, line 23; page 9, line 29 - page 10, line 3 --	1-11
A	EP 0569314 A1 (AMPER S.A.), 10 November 1993 (10.11.93), see whole document -- -----	1-11

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Date of the actual completion of the international search

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Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT

Information on patent family members

31/07/96

International application No.

PCT/FI 96/00185

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO-A1- 9506995	09/03/95	AU-A- 7675694 CA-A- 2144859 CN-A- 1114124 DE-T- 4496552 DK-A- 48795	22/03/95 09/03/95 27/12/95 05/10/95 25/04/95
WO-A1- 9014729	29/11/90	AU-B- 621752 AU-A- 5569590 CA-A, C- 2032163 CN-A- 1047181 EP-A- 0431096 JP-T- 3506109 KR-B- 9409476 US-A- 5117450 US-A- 5247565	19/03/92 18/12/90 11/11/90 21/11/90 12/06/91 26/12/91 13/10/94 26/05/92 21/09/93
EP-A1- 0569314	10/11/93	DE-T- 569314 ES-A, B- 2043550	06/10/94 16/12/93

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